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ABSTRACT

This core curriculum contains five units for use in teaching metrics to vocational students. Included in the first unit are a series of learning activities to familiarize students with the terminology of metrics, including the prefixes and their values. Measures of distance and speed are covered. Discussed next are measures of volume used with solids and liquids. Terminology of metric weight and mass measurement as well as conversion to the metric system from the American standard system are addressed in a series of activities. The final unit consists of exercises to enable students to relate temperature scales to one another. Included in each unit are a terminal objective, specific objectives, suggested activities, a listing of instructional materials provided, references, information sheets, student handouts, unit tests, and test answers. (A related basic core curriculum for teaching energy to vocational agriculture students is available separately--see note.) (MN)

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METRICS

A Basic Core Curriculum for Teaching Metrics to Vocational Students

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METRICS

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METRICS

UNIT I

METRIC GLOSSARY

TERMINAL OBJECTIVE

Upon completion of this unit, students will be able to demonstrate familiarity with the terminology of metrics, including the prefixes and their values. This objective will be considered achieved by scoring at least eighty-five percent on the test.

SPECIFIC OBJECTIVE

After completion of this unit, students will be able to:

1. Name the terms which define the four basic areas of metric measurement. (distance, liquid, weight, and termperature)
2. Name the prefixes and identify the value of each prefix.
3. State the symbols used in abbreviating metrics.
4. Demonstrate the relationship between measures using the decimal system.

METRICS

UNIT I

SUGGESTED ACTIVITIES

Instructor:

1. Provide students with Objective Sheet
2. Provide students with Information and Assignment Sheets
3. Provide students with Student Handouts
4. Discuss Terminal and Specific Objectives
5. Discuss Information and Assignment Sheets
6. Discuss Student Handouts
7. Give Test

Students:

1. Read Objectives
2. Study Information Sheets and Student Handouts
3. Complete Assignment Sheets and turn in to instructor
4. Take Test

INSTRUCTIONAL MATERIALS

Included in this unit:

1. Objectives
2. Information Sheets
3. Student Handouts
   - #1 - Introduction to the Metric System
   - #2 - Metrics and the Decimal System
4. Assignment Sheets
   - #1 - Units of Measure and Prefixes
   - #2 - Metric Symbols
5. Answers to Assignment Sheets

INSTRUCTIONAL MATERIALS

6. Test

7. Answers to Test

References:

1. Gilbert, Thomas F. and Marilyn B. Thinking Metric (2nd ed.). New York: John Wiley and Sons, Inc. Publishers, 1978.

2. Kempf, Albert F. and Thomas J. Richards. The Metric System Made Simple. Garden City, New York: Doubleday and Company, Inc., 1973.

3. Albracht, James and Ray Kurtz. Introduction to Ag Metrics. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1978.

4. Metric Education for the World of Work, a workshop program conducted by Dr. James Albracht and Dr. Ray Kurtz of the Kansas State University.

5. "Metrics for ...," a series of booklets introducing metrics for many different types of vocation, prepared by the Center for Vocational Education, Ohio State University, Columbus, Ohio.

METRICS

UNIT I

INFORMATION SHEET

I. Terms and Definitions

A. Metrics or metric system - A decimal system of weights and measures having as fundamental units the gram, the meter, and the liter

B. NAS or the North American Standard - The common system of weights and measures used in the United States and a few other small nations

C. Meter - The basic unit of distance or length, officially defined as "the wavelength of orange-red light emitted by a krypton 86 atom," the meter is just slightly longer than three feet or one yard (NAS)

D. Liter - The basic unit of liquid (volume) measure, slightly more than one quart, four liters makes a little over a gallon

E. Gram - The basic unit of weight (or mass) measure, roughly the weight of a paperclip, there are just over 28 grams in an ounce

F. Degree Celsius - The unit of measure for temperature, the metric degree is equal to one-hundredth of the difference between the freezing and boiling points of water

G. Prefix or multiplier - The term which indicates the relationship of the unit size being measured and the basic unit for the type of measurement being done

II. Prefixes and Their Values

A. Micro - one millionth of

B. Milli - one thousandth of

C. Centi - one hundredth of

D. Deci - one tenth of

E. Deka - ten times

F. Hecto - one hundred times

G. Kilo - one thousand times

H. Mega - one million times

INFORMATION SHEET

III. Metric Symbols

A. Meter - m

B. Liter - l

C. Gram - g

D. Degree Celsius - ^{o}C

E. Micro - μ

F. Milli - m

G. Centi - c

H. Deci - d

I. Deka - da

J. Hecto - h

K. Kilo - k

L. Mega - M

(Note: The symbol for micro, μ, is the Greek letter m; the symbol for mega is always the upper case letter M to distinguish ti from all of the other m symbols.)

METRICS

UNIT I

STUDENT HANDOUT #1: Introduction to the Metric System

Day by day the metric system becomes more and more a part of our life. The weather report includes the temperature in degrees Celsius. Soft drinks are sold in two-liter bottles. The arrival of import automobiles in large quantities has brought nuts and bolts sized by millimeter rather than fractions of an inch. Even the American made cars now have a scale on their speedometers that shows speed in kilometers per hour. Road signs report that it is 100 Kilometers to the next large city. Metrics are all around us it seems. Why?

The simple answer to that question would be that it is because President Ford signed a national metrification law in December of 1975 which required that our country begin the process of a total conversion to the metric system. That answer is not adequate, however. The reason the issue ever came up at all is that by the 1970's over 90% of all the nations in the world were using the metric system. The United States, usually a leader, is now one of the last countries to convert to metrics. It became necessary for the U.S. to change if the nation was to continue to play a part in international economics. In order to prevent the economic isolation of the country the Congress and President Ford committed the nation to making the change.

Why did the metric system become <u>the</u> system for measurement in the world? For years we all got along with the old North American System (NAS) of measurement. Unfortunately, the NAS is a very clumsy system of measuring things. Twelve inches to the foot, three feet to the yard, and one thousand seven hundred and sixty (1760) yards to the mile may seem simple enough, but it doesn't tell the whole story. In addition to these measures we have such units as the fathom (six feet or two yards), the rod (5.5 yards or 16.5 feet), and the furlong (40 rods, 220 yards, or 660 feet). Conversion from one unit to another requires a mathematical operation which can be rather tricky. For example, try to quickly convert 14 feet into inches. Times up. Could you do it? Many people know the multiplication table through 12 times 12 equals 144. Very few people

STUDENT HANDOUT #1

know without having to do some kind of figuring that 12 times 14 equals 168. For a slightly more difficult example, try converting 17 yards into inches. Got it yet? Okay, keep trying. Notice that it takes two fairly simple operations to make this conversion, or one more complex operation.

1.	2.		3.
17	51		36
x 3	x 12	or	x 17
51	612		612

To convert from one unit of measure to another requires that we remember a different conversion ratio for each step up or down. And before you say that it doesn't seem so difficult, remember that the NAS measurements include ounces, pounds, pints, quarts, pecks, gallons, bushels, barrels, hogsheads, tons, and long tons among others. To make matters worse, some terms have two different meanings depending on whether liquids or dries are being measured.

Confused? That's not surprising. It was just that kind of confusion that the metric system was designed to eliminate. Where the NAS has almost as many conversion ratios as there are units of measure, the metric system has really only one conversion ratio: 10. Every conversion from one unit of measure to another involves only the use of ten or a multiple of ten. We are all used to counting by tens. Multiplying by ten or dividing by ten is the easiest mathematical operation that there is to do. By using the decimal system of counting numbers, conversion of units becomes a easy matter of shifting the decimal point. What could be simpler?

What about all of the conversion ratios you've heard for converting NAS measurements to metric measurements? They don't sound simple. To be honest, they aren't that easy to use. The problem lies with the fact that conversion from NAS to metric suggests that we are still using two systems and expecting them to remain equal in our minds. When we really begin to "think metric" we won't have to try to convert from one system to the other. Instead, we will almost automatically know when the weatherman say that it is 37° outside that the temperature is almost too warm even to go swimming.* Eventually we will stop seeing things with NAS measurements and will learn the metric system without the need for a crutch such as conversion to NAS. Until then, the best that we can do is to try to

STUDENT HANDOUT #1

"think metric" as much as possible. The purpose of these materials is to help you learn to do just that.

THINK METRIC!!

---

*37°on the Celsius scale just happens to be normal body temperature: 98.6°Fahrenheit.

METRICS

UNIT I

STUDENT HANDOUT #2: Metrics and the Decimal System

The terminology of metrics is created by combining the prefixes and the basic units to indicate the exact type of unit of measurement being used. For example, one thousandth of a meter is called a millimeter. The terms are written without the hyphen, such as millimeter. By combining the prefixes and basic units, virtually any type of measurement can be referred to easily. The symbols are combined in the same way, as in mm for millimeter.

Because the prefixes all represent multiples of 10, the decimal system of writing numbers is well suited for expressing the relationship between the various units. Deci- can be expressed as 0.1, centi- becomes 0.01, and so on. Using the decimal system, one centimeter can be writen as 0.01 liter. Changing from one size of measurement unit to another is a simple matter of shifting the decimal point.

METRICS

UNIT I

ASSIGNMENT SHEET #1: Units of Measure and Prefixes

1. Name the metric unit of measure for each of the following types of measurement.

   a. liquid = _____

   b. temperature = _____

   c. distance = _____

   d. weight = _____

2. Name the proper multiplier or prefix for each of the following sizes.

   a. one millionth of = _____

   b. one hundred times = _____

   c. one tenth of = _____

   d. one thousandth of = _____

   e. one thousand times = _____

   f. one million times = _____

   g. one hundredth of = _____

   h. ten times = _____

3. Combine the proper prefix with the correct basic unit.

   Example: one thousandth of/distance = millimeter

   a. one thousand times/weight = _____

   b. one hundredth of/distance = _____

   c. one thousandth of/liquid = _____

   d. one tenth of/weight = _____

   e. ten times/distance = _____

   f. one million times/liquid = _____

METRICS

UNIT I

ASSIGNMENT SHEET #2: Metric Symbols

1. State the proper symbols for each of the following metric units or prefixes.

   a. hecto- _____
   b. gram _____
   c. mega- _____
   d. centi- _____
   e. meter _____
   f. micro- _____
   g. liter _____
   h. deka- _____
   i. kilo- _____
   j. deci- _____
   k. milli- _____
   l. degree Celsius _____

2. Identify the unit of measurement referred to by the following abbreviations.

   a. cm = _____
   b. ml = _____
   c. kg = _____
   d. l = _____
   e. hm = _____
   f. Mm = _____

3. Change each of the following measurements to the decimal equivalent in the root size. Follow the example.

   Example: 1 cm = 0.01 m

   a. 1 hg = _____
   b. 1 ml = _____
   c. 1 km = _____
   d. 1 dm = _____
   e. 1 cl = _____
   f. 1 Mg = _____

UNIT I

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. a. liter
   b. degree Celcius
   c. meter
   d. gram

2. a. micro-
   b. hecto-
   c. deci-
   d. milli-
   e. kilo-
   f. mega-
   g. centi-
   h. deka-

3. a. kilogram
   b. centimeter
   c. milliliter
   d. decigram
   e. dekameter
   f. megaliter

Assignment Sheet #2

1. a. h
   b. g
   c. M
   d. c
   e. m
   f.
   g. l
   h. da
   i. k
   j. d
   k. m
   l. ^{o}C

2. a. centimeter
   b. milliliter
   c. kilogram
   d. liter
   e. hectometer
   f. megameter

3. a. 100 g
   b. 0.001 l
   c. 1000 m
   d. 0.1 m
   e. 0.01 l
   f. 1,000,000 g

METRICS

UNIT I

TEST

1. Name the basic unit of measurement or the prefix for each of the following.

   a. one thousand = _____

   b. one hundredth of = _____

   c. weight = _____

   d. one millionth of = _____

   e. one tenth of = _____

   f. liquid = _____

   g. ten times = _____

   h. distance = _____

   i. one thousandth of = _____

   j. one million times = _____

2. Identify the unit of measure referred to by the following.

   a. g _____

   b. dam _____

   c. mm _____

   d. Ml _____

   e. km _____

3. Express each of the following in its root size (basic unit).

   a. 1 kg = _____

   b. 1 mm = _____

   c. 1 hm = _____

   d. 1 dl = _____

   e. 1 cg = _____

METRICS

UNIT I

ANSWERS TO TEST

1. a. kilo-
   b. centi-
   c. gram
   d. micro-
   e. deci-
   f. liter
   g. deka-
   h. meter
   i. milli-
   j. mega-

2. a. gram
   b. dekameter
   c. millimeter
   d. megaliter
   e. kilometer

3. a. 1000 g
   b. 0.001 m
   c. 100 m
   d. 0.1 l
   e. 0.01 g

METRICS

UNIT II

MEASURES OF DISTANCE AND SPEED

TERMINAL OBJECTIVE

Upon completion of this unit, students will be able to identify appropriate size ranges for different types of measurements, demonstrate familiarity with the metric system, and be able to solve problems involving the use of metric measures of distance and speed. This objective will be considered achieved by scoring at least eighty-five percent on the test.

SPECIFIC OBJECTIVE

After completion of this unit, students will be able to:

1. Match a unit of measure to a distance to be measured.
2. Convert measurements from one unit to another. (Assignment Sheet #1)
3. Estimate with accuracy smaller distances. (Assignment Sheet #2)
4. Compute time necessary to travel distances. (Assignment Sheet #3)
5. Solve problems involving metric computations. (Assignment Sheet #4)

METRICS

UNIT II

SUGGESTED ACTIVITIES

Instructor:

1. Provide students with Objective Sheet
2. Provide students with Information and Assignment Sheets
3. Provide students with Student Handout
4. Make Transparency
5. Discuss Terminal and Specific Objectives
6. Discuss Information and Assignment Sheets
7. Discuss Student Handout
8. Select items to be estimated (Assignment Sheet #2) and measure them to determine the answers
9. Give Test

Students:

1. Read Objectives
2. Study Information Sheet and Student Handout
3. Complete Assignment Sheets and turn in to instructor
4. Take Test

INSTRUCTIONAL MATERIALS

Included in this unit:

1. Objectives
2. Information Sheet
3. Student Handout
4. Transparency Master

   TM 1 - MPH-KM/H
5. Assignment Sheets

   #1 - Unit Size

INSTRUCTIONAL MATERIALS

#2 - Estimating Distance

#3 - Problems in Speed and Area

#4 - Adding and Subtracting Metrics

6. Answers to Assignment Sheets

7. Test

8. Answers to Test

References:

1. Gilbert, Thomas F. and Marilyn B. Thinking Metric (2nd ed.). New York: John Wiley and Sons, Inc. Publishers, 1978.

2. Kempf, Albert F. and Thomas J. Richards. The Metric System Made Simple. Garden City, New York: Doubleday and Company, Inc., 1973.

3. Albracht, James and Ray Kurtz. Introduction to Ag Metrics. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1978.

4. Metric Education for the World of Work, a workshop program conducted by Dr. James Albracht and Dr. Ray Kurtz of the Kansas State University.

5. "Metrics for ...," a series of booklets introducing metrics for many different types of vocation, prepared by the Center for Vocational Education, Ohio State University, Columbus, Ohio.

METRICS

UNIT II

INFORMATION SHEET

I. Terms and Definitions

A. Meter - The basic unit of distance (or length) measurement, it is slightly longer than one yard, being equal to 39.37 inches (symbol m)

B. Millimeter - One thousandth of a meter, it is 0.03937 inch, for practical purposes this is the smallest unit of measure used (the micro-meter, called a micron, is so small that it is used almost exclusively in science) (symbol for millimeter - mm)

C. Centimeter - One hundredth of a meter, 2.54 centimeters is equal to one inch (symbol cm)

D. Decimeter - One tenth of a meter; not commonly used (symbol dm)

E. Dekameter - Ten meters, seldom used, it is equal to just over 32.8 feet or just under 11 yards (symbol dam)

F. Hectometer - One hundred meters, seldom used, it is about equal to 109 yards 1 foot (symbol hm)

G. Kilometer - One thousand meters, the common unit for measuring longer distances, used as the mile is used in the NAS, equal to 0.6212 mile (symbol km)

H. km/h - Kilometers per hour, the common measurement of speed, any rate of speed can be expressed using this format, such as cm/h (centimeters per hour)

I. m^2 - Square meter, a unit for measuring area, any size area can be expressed using this format, such as cm^2 (square centimeter)

J. Centare - An area equal to one square meter

K. Are - An area equal to one square dekameter (100 centares)

L. Hectare - An area equal to one square hectometer, used as acre is used, it is equal to 2.47 acres (10,000 centares)

METRICS

UNIT II

STUDENT HANDOUT #1

The basic unit of measure for distance is the meter. In the NAS measurements, a meter is just a shade longer than 39 1/3 inches. More precisely, it is 39.37 inches. To visualize this distance, imagine holding a yard stick upright from the floor by using your index finger on the end of the stick. One meter would be just about from the knuckle of that finger to the floor. To visualize two meters keep in mind the idea that professional basketball players are generally two meters or more in height.

Obviously it is not convenient to measure all distances by meters or decimal fractions of meters. This is where the multipliers (prefixes) come into use. Distances smaller than one meter may be expressed more easily by using centimeters or millimeters. Very short distances require the use of the micrometer. (The micrometer is actually called a micron, and is so small it is used almost exclusively in science.) Longer distances are measured in dekameters or hectometers occasionally, but most often in kilometers. The chart below shows the equivalent units of measure in the NAS and metric systems.

NAS	Metric
fraction of an inch	millimeter
inch	centimeter
foot	(decimeter, seldom used)
yard	meter
mile	kilometer

Picking the proper unit of measurement with metrics is no more difficult than with the NAS. All it takes is a feel for the size of the distance being measured, and an understanding of the meaning of the various multipliers. By now you should be familiar enough with the multipliers to complete the first exercise.

The best way to get a feel for a system of measurement is to use it. Get a metric ruler or tape measure and begin measuring things around

STUDENT HANDOUT #1

you. See how big the things you live with every day are in metric units. Make a list. Once you have measured the things around you, try measuring yourself. How tall are you? What is the width of your hand span from thumb tip to little finger tip? With arms outstretched, what is your arm span from finger tip to finger tip? How wide is one finger? Two fingers? Four fingers? Be creative, and make a list, something like this:

hand span-----22cm
middle bone of index finger-----3cm
width of hand-----11cm
three finger tips-----4.5cm or 45mm
width of index finger-----19mm
index finger, knuckle to tip-----10.5cm
neck size-----43.7cm or 437mm or 0.437m

Of course, each person is different, and will have his own set of measurements. The important thing is to have a feel for how big metric units are. With that awareness it becomes possible to estimate distances. For example, if your hand span measures 22 cm as in the list above, and you discover that a concrete block used in building a wall is one span wide, then by counting the number of rows of blocks in the wall and multiplying by 22 cm you can get a very good estimate of the height of the wall. Try estimating the size of a piece of paper using body measures, then check your estimate. Now try estimating other distances in the room.

Speed is a function of distance traveled in a certain period of time. We are all familiar with the term miles-per-hour as a reference to how fast we are traveling. Fifty-five miles per hour indicates speed by saying that at that rate the distance of fifty-five miles will be covered in one hour of non-stop driving. The standard abbreviation "mph" may also be stated m/h (miles/hour). The common speed reference in metrics is kilometers per hour (km/h). Most late model automobiles show both mph and km/h on their speedometers. Eventually the mph reading will be dropped and only the km/h will appear.

Many different rates of speed can be stated using the form of nota-

tion stated above. For example, a snail's pace might be described as 25 cm/h (centimeters per hour). The speed with which a wall is painted could be described as 15 m^2/h (square meters per hour). Faster speeds can be referred to by replacing the "h" for hour with an "m" for minute or "s" for second, such as m/m or km/s.

Did you notice the symbol for square meter above? This is the standard form for symbolizing area. You will see such things as mm^2, cm^2, m^2, km^2, and so on. Area is the product of multiplying length times width, and is always stated in terms of square units.

The amount of time necessary to travel a given distance is figured the same in metrics as in NAS. The formula is:

$$\frac{d}{s} = t$$

with d being distance to be traveled, s being the rate of travel (speed), and t being the amount of time. For example, a ninety kilometer trip at an average speed of sixty kilometers per hour would be figured like this:

$$\frac{90 \text{ km}}{60 \text{ km/h}} = t \qquad \frac{90}{60} = t \qquad 1.5 \text{ hours} = t$$

Keep in mind that t is always expressed in terms of the type of time unit used in the speed figure. Exercise 2-3 will give you the chance to practice figuring time and distances.

Adding and subtracting metric distances is a very simple matter, unlike with the NAS distances. Since there are ten millimeters in the centimeter, and ten centimeters in the decimeter, and ten decimeters in the meter, adding and subtracting is just like adding and subtracting four or more digit numbers. For example:

$$\begin{array}{rr} & 1 \text{ m } 2 \text{ dm } 3 \text{ cm } 4 \text{ mm} \\ + & 5 \text{ m } 6 \text{ dm } 7 \text{ cm } 8 \text{ mm} \\ \hline & 6 \quad 8 \quad 10 \quad 12 \end{array}$$

but, like in regular addition, since there cannot be more than nine units to a column before there is one for the next column, we carry the ones from both the mm and cm columns. Thus

$$\begin{array}{rr} & 1 \text{ m } 2^{1}\text{dm } 3^{1}\text{cm } 4 \text{ mm} \\ + & 5 \text{ m } 6 \text{ dm } 7 \text{ cm } 8 \text{ mm} \\ \hline & 6 \text{ m } 9 \text{ dm } 1 \text{ cm } 2 \text{ mm} \end{array}$$

STUDENT HANDOUT #1

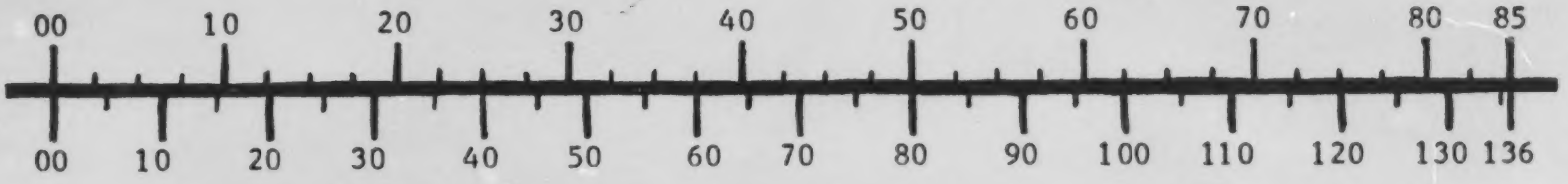
or, since we don't commonly use the decimeter, 6 m 91 cm 2 mm. This form works just as it is up to 999 meters, 99 centimeters, and 9 millimeters. The addition of one more millimeter makes that total 1 kilometer. In use one might see something like

1 km 234 m 5 cm 6 mm

Since the size symbols serve only to identify the columns, and since the addition is so simple, it is even possible to do these calculations without inserting the abbreviations, such as:

$$\begin{array}{r} 1\ 23\ 4 \\ +\ 5\ 67\ 8 \\ \hline 6\ 91\ 2 \end{array}$$

In using this short form, be sure to remember that the space between columns divides different sizes of units (and that there are 100 cm to the meter).


MILES----MILES PER HOUR
00 10 20 30 40 50 60 70 80 85
00 10 20 30 40 50 60 70 80 90 100 110 120 130 136
KILOMETERS----KILOMETERS/HOUR

METRICS

UNIT II

ASSIGNMENT SHEET #1: Unit Size

Note: Read Student Handout #1.

1. Choose the most appropriate unit of measure for each of the following types of distances.

   a. The length of a pencil _____

   b. The thickness of a coin _____

   c. The trip from home to school _____

   d. The distance to the moon _____

   e. The length of an inseam _____

   f. The width of a football field _____

   g. The height of a tall building _____

   h. The distance between two towns _____

   i. The width of a pencil _____

   j. The distance between adjacent threads on a screw _____

2. Convert each of the following to a more convenient size. Use the example as a guide.

   Example: 435 mm = 0.435 m or 43.5 cm

   a. 22,500 m = _____

   b. 187 cm = _____

   c. 0.052 km = _____

   d. 0.1 cm = _____

   e. 100 mm = _____

METRICS

UNIT II

ASSIGNMENT SHEET #2: Estimating Distance

Use this sheet to write down your estimates for the various distances which your instructor assigns.

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

METRICS

UNIT II

ASSIGNMENT SHEET #3: Problems in Speed and Area

Note: Review Student Handout #1.

1. Solve the following time and distance problems.

   a. How long will it take to travel 25 km at an average speed of 75 km/h?

   b. If the speed limit is 90 km/h, can a distance of 35 km be driven half an hour without exceeding the speed limit?

   c. How long will it take a train traveling at an average speed 120 km/h to travel 600 km?

   d. How long will it take for a plane flying at 700 km/h average speed to fly the 4800 km between Los Angeles and New York?

   e. If your employer wants you to make a delivery in a town which is 28 km away and be back in 30 minutes, can you do it without exceeding the speed limit?

2. Solve the following problems for the speed of travel.

   a. 25 km in 45 minutes = _____

   b. 200 km in 3 hours = _____

   c. 20 km in 20 minutes = _____

   d. 15 cm in 5 minutes = _____

   e. 23 m^2 in 1.5 hours = _____

3. Compute the area in each of the following problems.

   a. 25 m by 50 m = _____

   b. 1 hm by 1 dam = _____

   c. 5 km by 7 km = _____

   d. 27 cm by 11 cm = _____

   e. 18 mm by 9 mm = _____

4. Solve the following problem.

   If you have a paint sprayer that will spray 25 m^2/h, how long will it take you to spray a wall which is 15 m long by 3 m high?

METRICS

UNIT II

ASSIGNMENT SHEET #4: Adding and Subtracting Metrics

Note: Review Student Handout #1.

1. Add the following metric distances.

a. 63 mm
+ 55 mm

b. 7? cm 8 mm
+ 39 cm 4 mm

c. 3 m 17 cm
+ 4 m 83 cm

d. 252 m 66 cm 9 mm
+ 69 m 72 cm 5 mm

e. 642 m 18 cm
+ 753 m 81 cm

f. 19 m 23 cm 8 mm
48 m 57 cm 6 mm
+ 33 m 48 cm 5 mm

2. Subtract the following metric distances.

a. 47 mm
- 22 mm

b. 93 cm 9 mm
- 14 cm 5 mm

c. 2 m 25 cm
- 1 m 77 cm

d. 1 km 230 m 18 cm
- 766 m 43 cm

e. 45 km 333 m
- 27 km 455 m

f. 15 m 0 cm 7 mm
- 8 m 37 cm 8 mm

3. Solve the following problems.

a. A fabric customer is purchasing 1.5 meters of one fabric, 2.25 meters of another, and 2.75 meters of a third. How much fabric is the customer buying all together?

b. A plumbing contractor needs to run a pipe 2 m 55 cm. The shortest length of pipe he has on hand is 4 m 37 cm. How much must he cut off to make the pipe fit?

c. A carpenter has to finish the painting on a room in a new house. The room measures 3 m by 4.5 m, with all walls being 2.5 m high. By experience the carpenter knows that 20 m^2 can be painted in an hour. How long will it take to paint the room?

d. A truck driver makes a regular delivery run each day from city A to cities B, C, and D, returning from D to A at the end of the day. The driver's employer has set the top speed of the truck at 77 km/h. Using the following distances, and allowing 45 minutes in each city for the delivery, what is the shortest time necessary to complete the run?

A to B = 35 km
B to C = 48 km
D to A = 62 km
C to D = 27 km

ASSIGNMENT SHEET #4

3. e. If two windows each require drapes 1 m 66 cm wide by 2 m 10 cm long, how many square meters of material will be needed to cover both windows?

METRICS

UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. a. cm
   b. mm
   c. km
   d. Mn
   e. cm
   f. m (dam is acceptable)
   g. m
   h. km
   i. mm
   j. mm

2. a. 2.25 km
   b. 1.87 m
   c. 52 m
   d. 1 mm
   e. 10 cm (or 1 dm)

Assignment Sheet #2

Select 10 items or distances within the room for the students to practice estimating. Measure the items yourself to use in checking the students estimations.

Assignment Sheet #3

1. a. 0.333 hours or 20 minutes
   b. yes
   c. 5 hours
   d. 6.86 hours or 6 hours 52 minutes
   e. no

2. a. 33.3 km/h
   b. 66.6 km/h
   c. 60 km/h
   d. 180 cm/h or 3 cm/m
   e. 15.3 m^2/h

3. a. 1250 m^2
   b. 1 km^2
   c. 35 km^2
   d. 297 cm^2
   e. 162 mm^2

4. 1.8 hours or 1 hour 48 minutes

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #4

1. a. 128 mm
   b. 1 m 17 cm 2 mm
   c. 8 m
   d. 322 m 39 cm 4 m
   e. 1 km 395 m 99 cm
   f. 101 m 29 cm 9 mm

2. a. 25 mm
   b. 79 cm 4 mm
   c. 48 cm
   d. 463 m 75 cm
   e. 17 km 878 m
   f. 6 m 62 cm 9 mm

3. a. 6.5 m
   b. 1 m 82 cm
   c. 1.875 hours or 1 hour 52 1/2 minutes
   d. 4 hours 37 minutes (4.61 hours)
   e. 2.64 m^2

METRICS

UNIT II

TEST

1. State the most appropriate size unit for measuring each of the following.

   a. The length of an automobile exhaust pipe _____

   b. The width of a piece of cloth _____

   c. The diameter of a nail head _____

   d. The side of a home lot _____

   e. The height of a dead tree _____

2. Convert the following measurements to a more convenient size unit.

   a. 3450 m = _____

   b. 1257 mm = _____

   c. 0.008 m = _____

   d. 0.3 cm = _____

   e. 839 cm = _____

3. Solve the following problems.

   a. 23 m 17 cm 8 mm
      + 18 m 92 cm 3 mm

   b. 533 m 89 cm
      449 m 87 cm
      + 997 m 8 cm

   c. 27 m 1 cm
      - 8 m 5 mm

   d. 5 km
      - 2 km 374 m 22 cm

   e. 17 km
      + 20 km 17 m 82 cm 3 mm

   f. 4.4 m
      x 2.6 m

   g. How long will it take to travel a distance of 750 km at an average speed of 48 km/h?

   h. What is the area of a piece of land measuring 25 m by 37 m 50 cm?

   i. What is the average speed of a trip 233 km long completed in 3 hours 45 minutes?

   j. If three pieces of pipe measuring 6 m 37 cm, 4 m 22 cm 8 mm, and 5 m 53 cm 6 mm were welded together end to end, how much would need to be cut off of the resulting pipe to make a 13 m 17 cm 5 mm connection?

METRICS

UNIT II

ANSWERS TO TEST

1. a. meters
   b. centimeters
   c. millimeters
   d. meters or dekameters
   e. meters

2. a. 3.450 km
   b. 1.257 m
   c. 8 mm
   d. 3 mm
   e. 8.39 m

3. a. 42 m 10 cm 1 mm
   b. 1 km 980 m 84 cm
   c. 19 m 5 mm
   d. 2 km 625 m 78 cm
   e. 37 km 17 m 82 cm 3 mm
   f. 11.44 m^2
   g. 15.625 hours or 15 hours 37 1/2 minutes
   h. 937.5 m^2
   i. 62.133 km/h
   j. 2 m 35 cm 9 mm

METRICS

UNIT III

MEASURES OF VOLUME: SOLID AND LIQUID

TERMINAL OBJECTIVE

Upon completion of this unit, students will be able to demonstrate familarity with the terminology of volume measurement, and to demonstrate ability to calculate and use metric volume measurements. This objective will be considered achieved by scoring at least eighty-five percent on the test.

SPECIFIC OBJECTIVE

After completion of this unit, students will be able to:

1. Calculate the volume of both rectangular and cylindrical shapes. (Assignment Sheet #1)
2. Convert from solid measurements to liquid and vice versa, and convert from one size unit to another. (Assignment Sheet #2)
3. Estimate with some accuracy smaller volumes. (Assignment Sheet #3)
4. Solve problems involving metric calculations. (Assignment Sheet #4)

METRICS

UNIT III

SUGGESTED ACTIVITIES

Instructor:

1. Provide students with Objective Sheet
2. Provide students with Information and Assignment Sheets
3. Discuss Terminal and Specific Objectives
4. Discuss Information and Assignment Sheets
5. Give Test

Students:

1. Read Objectives
2. Study Information Sheet
3. Complete Assignment Sheets and turn in to instructor
4. Take Test

INSTRUCTIONAL MATERIALS

Included in this unit:

1. Objectives
2. Information Sheet
3. Assignment Sheets
   - #1 - Calculating Volume
   - #2 - Converting from Solid or Liquid
   - #3 - Estimating Volume
   - #4 - Problems in Metric Volume
4. Answers to Assignment Sheets
5. Test
6. Answers to Test

INSTRUCTIONAL MATERIALS

References:

1. Gilbert, Thomas F. and Marilyn B. Thinking Metric (2nd ed.). New York: John Wiley and Sons, Inc. Publishers, 1978.

2. Kempf, Albert F. and Thomas J. Richards. The Metric System Made Simple. Garden City, New York: Doubleday and Company, Inc., 1973.

3. Albracht, James and Ray Kurtz. Introduction to Ag Metrics. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1978.

4. Metric Education for the World of Work, a workshop program conducted by Dr. James Albracht and Dr. Ray Kurtz of the Kansas State University.

5. "Metrics for ...," a series of booklets introducing metrics for many different types of vocation, prepared by the Center for Vocational Education, Ohio State University, Columbus, Ohio.

METRICS

UNIT III

INFORMATION SHEET

I. Terms and Definitions

A. Liter - The basic unit of liquid volume measurement, technically a liter is equal to one cubic decimeter, by definition, in other words, a cube measuring one decimeter (10 cm) on each side will hold exactly one liter (symbol l)

B. Milliliter - The most common fractional unit of a liter used for measurement, one thousandth of a liter (symbol ml)

C. Cubic meter - The basic unit for measuring volume other than liquid, obviously the term refers to a unit of volume equal to a cube one meter on each side (symbol m^3)

D. Cubic (x) - Any size unit of volume may be expressed in cubic form, such as cubic centimeter (cm^3) or cubic kilometer (km^3) Note: cubic centimeter is commonly abbreviated cc.

II. Conversion from Liter to Cubic Measurement

A. One cubic decimeter is equal to 1,000 cubic centimeters (10 cm X 10 cm X 10 cm). One liter is therefore equal to 1,000 cm^3

B. One milliliter (1 ml) is equal to one thousandth of a liter. Therefore, since one milliliter is equal to one thousandth of 1,000 cubic centimeters, one milliliter is equal to one cubic centimeter

III. Computing Volume

A. L x W x H - The formula for computing volume in cubic units, with L being length, W the width, and H the height (or depth) of the item being measured

B. To compute the volume of a cylinder, figure the area of one end surface (one half the diameter times itself, or squared, times pi, a number equal to 3.1416 approximately) and multiply by the length of the cylinder, the resulting measurement is in cubic units

METRICS

UNIT III

ASSIGNMENT SHEET #1: Calculating Volume

1. Calculate the volume of the following containers.

   a. A box 10 cm wide, 15 cm long, and 8 cm tall = _____

   b. A room 4 m long, 3 m wide, and 2.5 m high = _____

   c. A box 6 cm long, 5 cm wide, and 4 cm tall = _____

   d. A box 30 mm long, 15 mm wide, and 25 mm tall = _____

   e. A cube 2.2 cm on each side = _____

   f. A block 3 cm by 3 cm by 6 cm = _____

   g. A carton 45 cm by 16 cm by 62 cm = _____

   h. A room 3.5 m by 3.5 m by 2.5 m = _____

   i. A pillbox 5 mm by 10 mm by 8 mm = _____

   j. A tank 20 cm by 40 cm by 23 cm = _____

2. Compute the volume of the following cylinders.
   (pi, times radius squared, times length; pi = 3.1416)

   a. Cylinder diameter 20 cm, length 20 cm = _____

   b. Diameter 10 cm, length 20 cm = _____

   c. Diameter 1 meter, length 2 m = _____

   d. Diameter 3 m, length 12 m = _____

   e. Diameter 15.5 m, length 25 m = _____

   f. Diameter 23 cm, length 4.5 dm = _____

   g. Diameter 55 cm, length 2.2 m = _____

   h. Diameter 4.5 m, length 15.5 m = _____

   i. Radius 44 cm, length 44 cm = _____

   j. Diameter 33 m, length 15 m = _____

METRICS

UNIT III

ASSIGNMENT SHEET #2: Converting from Solid to Liquid

1. Convert the following measurements.

   a. 7.54 l = _____ml

   b. 0.456 l = _____ml

   c. 65 l = _____ml

   d. 0.5 l = _____ml

   e. 3,450 ml = _____l

   f. 78.5 ml = _____l

   g. 5 ml = _____l

   h. 250 ml = _____l

   i. 375 ml = _____cl

   j. 29.35 dl = _____ml

2. Convert the following liquid measures to solid measurements.

   a. 1 ml = _____cc

   b. 1.5 l = _____cc

   c. 1.3 dal = _____dm^3

   d. 235 ml = _____cc

   e. 17.340 l = _____cc

3. Convert the following solid measures to liquid measurements.

   a. 570 cc = _____l

   b. 23 dm^3 = _____ml

   c. 24.5 dm^3 = _____dal

   d. 2389 cc = _____l

   e. 1 cc = _____l

METRICS

UNIT III

ASSIGNMENT SHEET #3: Estimating Volume

Estimate the volume of the containers which your instructor has selected. Use this sheet to record your estimates.

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

METRICS

UNIT III

ASSIGNMENT SHEET #4: Problems in Metric Volume

1. 2 l 23 ml
   + 8 l 325 ml

2. 475 ml
   + 723 ml

3. 47 l 778 ml
   + 19 l 433 ml

4. 55 l 98 ml
   + 7 l 202 ml

5. 17 l 933 ml
   - 9 l 453 ml

6. 8 l 145 ml
   - 6 l 451 ml

7. 24 l 689 ml
   - 23 l 986 ml

8. A grain storage unit consists of 6 silos, each 13 m in diameter and 21 m tall. What is the total storage capacity of the unit?

9. A large tank holds 53,000 l. In cubic meters, what is the volume of the tank?

10. Four bottles, each containing 0.5 l are on a table. From the first bottle 125 ml are emptied into a bowl, from the second 100 ml, from the third 433 ml, and from the fourth 295 ml. How much remains in each of the four bottles? What is the total of the remaining contents of the bottles? How much is in the bowl? How many half liter bottles are necessary to hold the contents of the bowl?

METRICS

UNIT III

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. a. 1200 cm^3
   b. 30 cm^3
   c. 120 cm^3
   d. 11,250 mm^3
   e. 10.648 cm^3
   f. 54 cm^3
   g. 44,640 cm^3
   h. 30.625 m^3
   i. 400 mm^3
   j. 18,400 cm^3

2. a. 6283.2 cm^3
   b. 1570.8 cm^3
   c. 1.5708 m^3
   d. 84.8232 m^3
   e. 4717.3087 m^3
   f. 18,696.447 cm^3 or 18.969447 dm^3
   g. 522,683.7 cm^3
   h. 246.51742 m^3
   i. 267,614.05 cm^3
   j. 12,829.509 m^3

Assignment Sheet #2

1. a. 7,450 ml
   b. 456 ml
   c. 65,000 ml
   d. 500 ml
   e. 3.45 l
   f. 0.0785 l
   g. 0.005 l
   h. 0.250 l
   i. 37.5 cl
   j. 2935 ml

2. a. 1 cc
   b. 1500 cc
   c. 13 dm^3
   d. 235 cc
   e. 17,340 cc

3. a. 0.570 l
   b. 23,000 ml
   c. 2.45 dal
   d. 2.389 l
   e. 0.001 l

Assignment Sheet #3

Select 10 different sized containers for the students to practice estimating volume. Measure and calculate the correct volume yourself for use in checking the students' estimates.

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #4

1. 10 l 348 ml
2. 1 l 198 ml
3. 67 l 211 ml
4. 62 l 300 ml
5. 8 l 480 ml
6. 1 l 694 ml
7. 703 ml
8. 16,724.31 m^3
9. 53 m^3
10. 375 ml, 400 ml, 67 ml, 205 ml
    1047 ml or 1 l 47 ml
    953 ml
    3

METRICS

UNIT III

TEST

1. Calculate the volume of the following containers. Pi = 3.1416

   a. A carton 35 cm by 15 cm by 22 cm = _____

   b. A box 23 mm by 23 mm by 12.5 mm = _____

   c. A tank 13 m in diameter, 37 m tall = _____

   d. A pool 100 m by 33.3 m by 3.5 m = _____

   e. A room 4.6 m by 5.2 m by 3.1 m = _____

   f. A tank 53.5 m in diameter, 17.4 m tall = _____

   g. A pan 30 cm in diameter, 23.5 cm deep = _____

   h. A dish 87 mm in diameter, 17 mm deep = _____

   i. A hall 133 m by 66 m by 22 m = _____

   j. A bottle 15 cm in diameter, 33.5 cm tall = _____

2. Convert the following measurements to the indicated units.

   a. 5919.95 cc = _____ l

   b. 16.611 l = _____ cc

   c. 173 ml = _____ l

   d. 379 ml = _____ dm^3

   e. 13.775 l = _____ dm^3

   f. 475 cc = _____ dm^3

   g. 23,869 cc = _____ ml

   h. 23,869 ml = _____ l

   i. 0.9515 dm^3 = _____ cc

   j. 2.345 l = _____ ml

TEST

3. Solve the following problems.

a.
$$\begin{array}{r} 13\ 1\ 27\ \text{ml} \\ 37\ 1\ 489\ \text{ml} \\ +\ 65\ 1\ 837\ \text{ml} \\ \hline \end{array}$$

b.
$$\begin{array}{r} 93\ 1\ 483\ \text{ml} \\ 559\ \text{ml} \\ +\ 48\ 1\ 372\ \text{ml} \\ \hline \end{array}$$

c.
$$\begin{array}{r} 16\ 1\ 323\ \text{ml} \\ -\ 13\ 1\ 745\ \text{ml} \\ \hline \end{array}$$

d.
$$\begin{array}{r} 22\ 1\ 65\ \text{ml} \\ -\ 17\ 1\ 853\ \text{ml} \\ \hline \end{array}$$

e. A tank farm has 25 tanks used for holding oil. Each tank is 45 m in diameter and 22 m tall. How many dekaliters will the whole tank hold?

METRICS

UNIT III

ANSWERS TO TEST

1. a. 11,550 cc
   b. 6612.5 mm^3
   c. 4917.9845 m^3
   d. 11,655 m^3
   e. 74.152 m^3
   f. 39.115.393 m^3
   g. 16,611.21 cc
   h. 101,059.77 mm^3
   i. 47,916 m^3
   j. 5919.9525 cc

2. a. 5.91995 l
   b. 16,611 cc
   c. 0.173 l
   d. 0.379 dm^3
   e. 13.775 dm^3
   f. 0.475 dm^3
   g. 2[illegible]69 ml
   h. 23.669 l
   i. 951.5 cc
   j. 2345 ml

3. a. 116 l 353 ml
   b. 142 l 414 ml
   c. 2 l 578 ml
   d. 4 l 212 ml
   e. 3,498,957 dal

METRICS

UNIT IV

MEASURES OF WEIGHT AND MASS

TERMINAL OBJECTIVE

Upon completion of this unit, students will be able to demonstrate familiarity with the terminology of metric weight and mass measurement, the ability to convert from NAS weights, and to use the system with ease. This objective will be considered achieved by scoring at least eighty-five percent on the test.

SPECIFIC OBJECTIVE

After completion of this unit, students will be able to:

1. Match terms and definitions.
2. Select an appropriate size unit for measurement. (Assignment Sheet #1)
3. Convert from pounds and ounces to grams and kilograms. (Assignment Sheet #1)
4. Estimate with some accuracy metric weights. (Assignment Sheet #2)

METRICS

UNIT IV

SUGGESTED ACTIVITIES

Instructor:

1. Provide students with Objective Sheet
2. Provide students with Information and Assignment Sheets
3. Discuss Terminal and Specific Objectives
4. Discuss Information and Assignment Sheets
5. Select items to be stimated (Assignment Sheet #2) and determine correct weights
6. Give Test

Students:

1. Read Objectives
2. Study Information Sheet
3. Complete Assignment Sheets and turn in to instructor
4. Take Test

INSTRUCTIONAL MATERIALS

Included in this unit:

1. Objectives
2. Information Sheet
3. Assignment Sheets

   #1 - Unit Size and Conversion

   #2 - Estimating Weight
4. Answers to Assignment Sheets
5. Test
6. Answers to Test

INSTRUCTIONAL MATERIALS

References:

1. Gilbert, Thomas F. and Marilyn B. Thinking Metric (2nd ed.). New York: John Wiley and Sons, Inc. Publishers, 1978.

2. Kempf, Albert F. and Thomas J. Richards. The Metric System Made Simple. Garden City, New York: Doubleday and Company, Inc., 1973.

3. Albracht, James and Ray Kurtz. Introduction to Ag Metrics. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1978.

4. Metric Education for the World of Work, a workshop program conducted by Dr. James Albracht and Fr. Ray Kurtz of the Kansas State University.

5. "Metrics for ...," a series of booklets introducing metrics for many different types of vocation, prepared by the Center for Vocational Education, Ohio State University, Columbus, Ohio.

METRICS

UNIT IV

INFORMATION SHEET

I. Terms and Definitions

A. Weight - Defined as the quality of heaviness, technically "the measure of the force with which bodies tend toward the cent of the earth or other celestial body, equal to the mass of the body multiplied by the acceleration due to gravitation (Funk and Wagnalls Standard Desk Dictionary)"

B. Mass - Technically "the measure of the inertia of a body, expressed as the quotient of the weight of the body divided by the acceleration due to gravity (Funk and Wagnalls)." Because the acceleration due to gravity at the surface of the earth is considered to be 1 G, mass and weight are equal at any point on the earth's surface, however, since weight is the product of acceleration on mass, if gravitational acceleration drops to zero weight will drop to zero also, but mass will remain

C. Gram - The basic unit of weight and mass measurement, the weight of one ml of water, roughly equal to the weight of a paperclip, NAS equivalent 1/28 of an ounce (symbol g)

D. Kilogram - The more common unit of weight and mass measurement due to the small size of the basic unit, commonly referred to as a kilo, equal to 2.2 pounds (symbol kg)

E. Milligram - Extremely small unit of weight and mass, used primarily in medicine and science, about the weight of a grain of salt (symbol mg)

F. Megagram - The proper term for the largest common unit for weight and mass measurement, commonly called the metric ton, the megagram is close to the 2000 pound ton of the NAS, the metric ton is 1000 kilograms and is equal to the weight of one cubic meter of water (symbol Mg, not commonly used)

METRICS

UNIT IV

ASSIGNMENT SHEET #1: Unit Size and Conversion

1. Choose the appropriate size unit for weighing the following.

   a. A dictionary _____

   b. A paperback book _____

   c. An automobile _____

   d. Grains of sand _____

   e. Small nails _____

2. Calculate the metric weight in the indicated unit for each of the following.

   a. 2.2 pounds = _____kg

   b. 1 ounce = _____g

   c. 23.7 pounds = _____kg

   d. 1.5 pounds = _____g

   e. 4325 pounds = _____Mg

   f. 8 ounces = _____g

   g. 7.5 pounds = _____kg

   h. 16 ounces = _____g

   i. 12,430 pounds = _____metric tons

   j. 175 pounds = _____kg

METRICS

UNIT IV

ASSIGNMENT SHEET #2: Estimating Weight

Estimate the weight of the objects which your instructor has selected for you. Use this sheet to record your estimates.

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

METRICS

UNIT IV

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. a. kilogram
   b. gram
   c. metric ton or megagram
   d. milligram
   e. gram

2. a. 1 kg
   b. 28 g
   c. 10.773 kg
   d. 0.682 kg
   e. 1.966 Mg
   f. 224 g
   g. 3.409 kg
   h. 448 g
   i. 5.65 metric tons
   j. 79.545 kg

Assignment Sheet #2

Select 10 different objects for the students to use in practicing estimating metric weight. Weigh each item to determine the correct weights.

METRICS

UNIT IV

TEST

1. Match the definitions on the right with the correct term in the space provided.

_____a.	Milligram	1.	Weight of one milliliter of water
_____b.	Metric ton	2.	Used primarily in science and medicine
_____c.	Mass	3.	Megagram
_____d.	Gram	4.	Remains even in zero gravity field

2. Select the appropriate size unit for weighing the following.

   a. Ingredients in a recipe _____

   b. A truck load _____

   c. A piece of furniture _____

   d. A person _____

   e. A steak _____

3. Convert to the metric weight each of the following.

   a. 19.25 pounds = _____

   b. 225 pounds = _____

   c. 5 ounces = _____

   d. 1899 pounds = _____

   e. 8.8 ounces = _____

   f. 457.33 pounds = _____

   g. 18.5 ounces = _____

   h. 9954.5 pounds = _____

   i. 1 pound = _____

   j. 2000 pounds = _____

METRICS

UNIT IV

ANSWERS TO TEST

1. a. 2
   b. 3
   c. 4
   d. 1

2. a. gram
   b. megagram or metric ton
   c. kilogram
   d. kilogram
   e. gram

3. a. 8.75 kg
   b. 102.273 kg
   c. 140 g
   d. 0.863 metric ton
   e. 246.4 g
   f. 207.877 kg
   g. 518 g
   h. 4.525 Mg or metric ton
   i. 0.4545 kg
   j. 0.909 Mg or metric ton

METRICS

UNIT V

MEASURES OF TEMPERATURE AND OTHER MEASURES

TERMINAL OBJECTIVE

Upon completion of this unit, students will be able to demonstrate familiarity with the terminology of metric temperature measurement, basic terms of other types of metric measures, and the ability to relate the different temperature scales to each other. This objective will be considered achieved by scoring at least eighty-five percent on the test.

SPECIFIC OBJECTIVES

After completion of this unit, students will be able to:

1. Match metric terms with the type of measurement being made. (Assignment Sheet #1)
2. Complete definition statements relating to temperature or other measurements. (Assignment Sheet #1)
3. Convert from one temperature scale to another. (Assignment Sheet #2)
4. Demonstrate familiarity with important metric temperatures. (TM 2,3 and Assignment Sheet #3)

METRICS

UNIT V

SUGGESTED ACTIVITIES

Instructor:

1. Provide students with Objective Sheet
2. Provide students with Information and Assignment Sheets
3. Make Transparencies
4. Discuss Terminal and Specific Objectives
5. Discuss Information and Assignment Sheets
6. Give Test

Students:

1. Read Objectives
2. Study Information Sheets
3. Complete Assignment Sheets and turn in to instructor
4. Take Test

INSTRUCTIONAL MATERIALS

Included in this unit:

1. Objectives
2. Information Sheets
3. Transparency Masters

   TM 1 - TEMPERATURE SCALES

   TM 2 - BODY TEMPERATURES

   TM 3 - HIGHER TEMPERATURES

4. Assignment Sheets

   #1 - Terminology

   #2 - Converting Temperature

   #3 - Temperature Drill

INSTRUCTIONAL MATERIALS

5. Answers to Assignment Sheets

6. Test

7. Answers to Test

References:

1. Gilbert, Thomas F. and Marilyn B. Thinking Metric (2nd ed.). New York: John Wiley and Sons, Inc. Publishers, 1978.

2. Kempf, Albert F. and Thomas J. Richards. The Metric System Made Simple. Garden City, New York: Doubleday and Company, Inc., 1973.

3. Albracht, James and Ray Kurtz. Introduction to Ag Metrics. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1978.

4. Metric Education for the World of Work, a workshop program conducted by Dr. James Albracht and Dr. Ray Kurtz of the Kansas State University.

5. "Metrics for ...," a series of booklets introducing metrics for many different types of vocation, prepared by the Center for Vocational Education, Ohio State University, Columbus, Ohio.

C. Newton - The unit for measuring force, or acceleration, a newton is

C. Newton - The unit for measuring force, or acceleration, a newton is defined as the amount of force required to accelerate 1 kilogram at the rate of one meter per second per second, under one gravity, newtons of gravitational pull can be found by dividing the weight in grams of the object by 100, or by multiplying the weight in kilograms by 10 (symbol N)

METRICS

UNIT V

INFORMATION SHEET

I. Terms and Definitions

A. Celsius scale - The temperature scale developed by Ander Celsius, based on the freezing and boiling points of water, the difference between those two points is divided into 100 degrees, so that freezing is zero and boiling is 100, though not the official temperature unit of metrics, degrees Celsius is the commonly accepted and used unit (symbol °C)

B. Kelvin scale - The official metric temperature measurement system, using the Celsius scale degrees, the kelvin scale starts at "absolute" zero, thus it never has any negative numbers for temperature, "absolute" zero is -273 °C, so degrees Celsius is always 273 plus the Celsius temperature on the kelvin scale (symbol K)

C. Newton - The unit for measuring force, or acceleration, a newton is defined as the amount of force required to accelerate 1 kilogram at the rate of one meter per second, under one gravity, newtons of gravitational pull can be found by dividing the weight in grams of the object by 100, or by multiplying the weight in kilograms by 10 (symbol N)

D. Pascal - A measure of pressure, equal to 1 newton of force spread over 1 square meter (N/m^2). One pascal is a very small amount of pressure, with 200,000 pascals being equal to 28 pounds per square inch (symbol Pa)

E. Bar - A unit of pressure common in meteorlogy, and equal to 100,000 Pa (symbol b)

F. Joule - The unit for measuring work, work is force times distance, and 1 joule is equal to a force of 1 N through a distance of 1 m, NAS equivalent is foot-pounds (symbol J)

G. Joules per second - The measure of power or rate of work, abbreviated J/s

H. Watt - Common measure of power, equal to 1 J/s (symbol W)

I. Kilowatt - A larger unit for measuring power, equal to 1000 watts or 1000 J/s, a kilowatt hour is 1 kilowatt of power times 1 hour (3600 seconds) or 3,600,000 joules (symbol for kilowatt kW; for kilowatt hour kWh)

INFORMATION SHEET

II. Converting from One Temperature Scale to Another

A. Fahrenheit to Celsius - The ratio fo Fahrenheit to Celsius is 1.8 to 1. Because Fahrenheit starts at 32 where Celsius has 0, the formula for F to C is:

$$\frac{f-32}{1.8} = c$$

B. Celsius to Fahrenheit - The formula for C to F is:

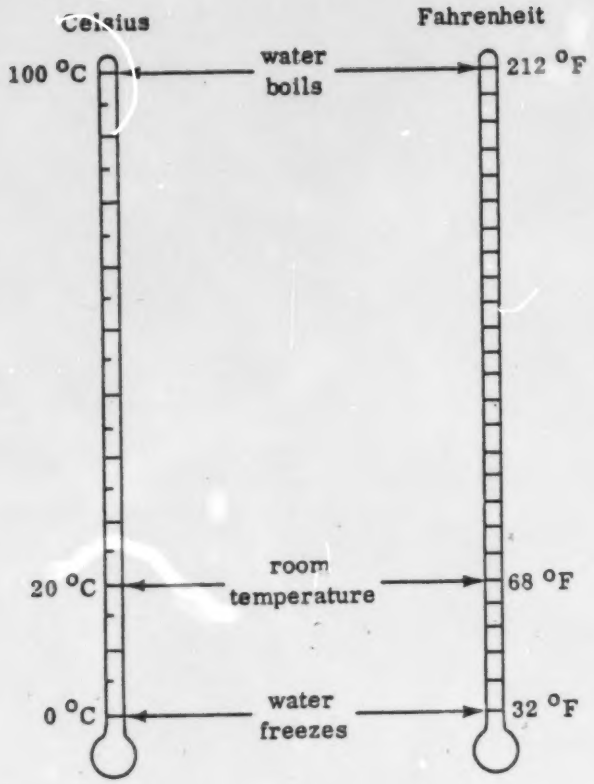
$$f = 1.8c + 32$$

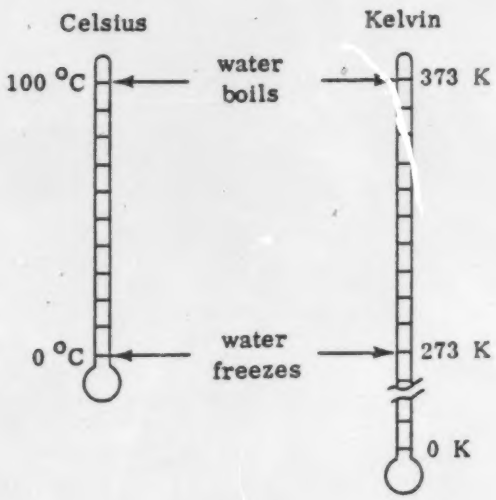
Multiply C reading by 1.8 and add 32

C. Celsius to Kelvin - Kelvin is always 273 plus the C reading.

$$k = c + 273$$

To convert from Fahrenheit to kelvin, first convert to Celcius, then to kelvin


Celsius
Fahrenheit
100 °C
water boils
212 °F
20 °C
room temperature
68 °F
0 °C
water freezes
32 °F


Celsius
Kelvin
100 °C
water boils
373 K
0 °C
water freezes
273 K
0 K

BODY TEMPERATURE

Temperature (^{o}F)	Temperature (^{o}C)	Body Condition
98.6	37	Normal
99.5	37.5	Slight cold
100.5	38	Low-grade fever
102	39	Flu
104	40	Very sick
105	40.5	Alarming
106	41	Convulsions

HIGHER TEMPERATURES

Temperature (°C)	Suitable for:
3000	Melting iron
1000	Melting gold
250	Broiling steak
200	Baking potatoes
175	Baking cookies
160	Baking Fish
150	Baking cake
125	Warming Bread
100	Boiling water

METRICS

UNIT V

ASSIGNMENT SHEET #1: Terminology

1. Match the following things to be measured with the proper symbol for the unit which measures it.

a. Pressure	f. W
b. Force	g. Pa
c. Work	h. ^{o}C
d. Temperature	i. J
e. Power	j. N

2. Complete the following statements.

   a. 1000 J/s is called _____.

   b. A newton is defined as the force necessary to accelerate _____ at the rate of 1 meter per second per second.

   c. Absolute zero is _____^{o}C.

   d. There are _____Pa in 1 bar.

   e. 1 kWh is equal to _____J.

3. State the following conversion formulas.

   a. Fahrenheit to Celsius - _____

   b. Celsius to kelvin - _____

   c. Celsius to Fahrenheit - _____

4. Name another unit of measure for measuring the same thing as each of the following

   a. pascal - _____

   b. watt - _____

METRICS

UNIT V

ASSIGNMENT SHEET #2: Converting Temperature

Convert the following temperatures to the indicated scale.

1. 88 ^{o}F = _____ ^{o}C
2. 88 ^{o}C = _____ ^{o}F
3. 350 ^{o}C = _____ ^{o}K
4. 864 ^{o}K = _____ ^{o}C
5. 400 ^{o}F = _____ ^{o}C
6. 25 ^{o}C = _____ ^{o}F
7. 37 ^{o}C = _____ ^{o}K
8. 275 ^{o}K = _____ ^{o}C
9. 325 ^{o}F = _____ ^{o}C
10. 60 ^{o}C = _____ ^{o}F
11. 275 ^{o}F = _____ ^{o}C
12. 33 ^{o}C = _____ ^{o}F
13. 313 ^{o}F = _____ ^{o}K
14. 305 ^{o}K = _____ ^{o}C
15. 98 ^{o}F = _____ ^{o}K

METRICS

UNIT V

ASSIGNMENT SHEET #3: Temperature Drill

1. State the body condition indicated by the following temperatures.

   a. 39 °C = _____

   b. 41 °C = _____

   c. 37 °C = _____

   d. 38 °C = _____

   e. 86 °C = _____

2. Identify what the following temperatures are suitable for.

   a. 250 °C = _____

   b. 125 °C = _____

   c. 3000 °C = _____

   d. 175 °C = _____

   e. 150 °C = _____

METRICS

UNIT V

ANSWERS TO ASSIGNMENT SHEETS

Assignment Shee #1

1. a. g
   b. j
   c. i
   d. h
   e. f

2. a. a kilowatt
   b. 1 kilogram
   c. -273
   d. 100,000
   e. 3,600,000

3. a. $\frac{f - 32}{1.8} = c$
   b. $k = c + 273$
   c. $f = 1.8c + 32$

4. a. bar
   b. kilowatt

Assignment Sheet #2

1. 31.1 °C
2. 190.4 °F
3. 623 °K
4. 591 °C
5. 204.4 °C
6. 77 °F
7. 310 °K
8. 2 °C
9. 162.7 °C
10. 140 °F
11. 135 °C
12. 91.4 °F
13. 429.1 °K
14. 32 °C
15. 309.6 °K

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #3

1. a. Flu-grade fever
   b. Convulsive fever
   c. Normal
   d. Low-grade fever
   e. Below normal

2. a. Broiling steak
   b. Warming bread
   c. Melting iron
   d. Baking cookies
   e. Baking cake

METRICS

UNIT V

TEST

1. Match the following symbols with what they measure.

a. kWh	f. force
b. b	g. temperature
c. ^{o}K	h. work
d. J	i. pressure
e. N	j. power

2. Complete the following statements.

   a. There are _____ degrees between freezing and boiling in the Celsius scale.

   b. 2 b = _____ Pa

   c. One pascal is equal to _____ of force spread over 1 square meter.

   d. 1 J is equal to 1 newton through a distance of _____.

   e. 1 W = _____ J/s

3. Convert the following temperatures to the indicated scale.

   a. 90 ^{o}F = _____ ^{o}C

   b. 90 ^{o}C = _____ ^{o}F

   c. 133 ^{o}F = _____ ^{o}K

   d. 475 ^{o}K = _____ ^{o}F

   e. 1573 ^{o}C = _____ ^{o}K

   f. 988 ^{o}K = _____ ^{o}C

4. State the temperature (^{o}C) which fits the following conditions.

   a. Iron melts - _____

   b. Cakes bake - _____

   c. Normal body temperature - _____

   d. Seriously ill - _____

METRICS

UNIT V

ANSWERS TO TEST

1. a. j
   b. i
   c. g
   d. h
   e. f

2. a. 100
   b. 200,000
   c. 1 N
   d. 1 m
   e. 1

3. a. 32.2 °C
   b. 194 °F
   c. 329.1 °K
   d. 395.6 °F
   e. 1846 °K
   f. 715 °C

4. a. 3000 °C
   b. 150 °C
   c. 37 °C
   d. 39 °C